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Climate Change and the Future of the American West: Exploring the Legal and Policy Dimensions (Summer Conference, June 7-9) 2006

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SLIDES: Agriculture: Climate Change Problem, Solution, or Both? and U.S. Agriculture and Climate Change: Challenge and Opportunity

David L. Carlson

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AGRICULTURE: CLIMATE CHANGE PROBLEM, SOLUTION, OR BOTH?

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NRLC Summer Conference – June 7-9, 2006

Preliminary Outline (5/506)

1. Agriculture, Energy Use, and GHGs

- Agricultural Production: energy use and GHG emissions (total, fossil, petroleum)
- Food and Agricultural System: energy use and GHG emissions
- Ag production demand driven by 1st World food and fiber consumption patterns

2. Ag Energy Use Breakout and Conservation Potential

- Crop production operations; use and conservation potential
- Livestock production operations; use and conservation potential
- *Innovative initiative: perennial polycultures (e.g., the Land Institute)*

3. Carbon Sequestration Potential by Agriculture

- Basic dynamics of carbon sequestration and fledgling market
- National carbon sequestration potential
- Iowa Farm Bureau Pilot Program
- Status of interest and activity in the West: e.g., Wyoming, Idaho, etc.
- *Aggregation problem: how track and compensate thousands of farmers with modest carbon storage credits in a cost-effective way?*

4. Renewable Energy Production from Agriculture and Rural America

- Biofuels – current and potential production; obstacles
- Wind – current and potential production; obstacles
- *Innovative initiative: Project 25x'25 vision: To produce 25% of the nation's energy from "America's working lands" by the year 2025*

5. Agriculture and Land Use

- Impact of land use patterns on energy use, hence on climate change
- Agricultural land conversion trends
- *Innovative initiative: large-scale land-pooling by owners of agricultural land*

6. Summary

- Interconnectedness of climate change and agriculture with other important public policy issues in the West: growth, water, trade policy, oil dependence, diet, etc.
- Important to tie responses to climate change to other important public policy goals, such as national security, sustainability, human development & well-being
- The way forward will require the convergence of economics, ecology, and ethics

U.S. Agriculture and Climate Change: **Challenge and Opportunity**

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U.S. Agriculture and Climate Change: **Outline**

1. Agriculture, Climate and Water
2. Agriculture and GHG Emissions
3. Agriculture, Energy and Biofuels

- CHALLENGE and OPPORTUNITY

1b. Agriculture, Climate and Water
three big challenges to ag water

In Colorado, for example:

1. Increased M&I demand (net +630,000 AF, 2030)

   - *Reductions in current irrigated acreage in Colorado (3.1 million acres in 2000) could range from 12% to 23% by the year 2030, depending upon the level of uncertainty with currently planned projects and processes.*

Computed from: *Statewide Water Supply Initiative: Executive Summary* (Colorado, 2004)

2. + Increased recreation & environmental demand
3. + Climate change (quite possibly hotter and drier)

1c. Agriculture, Climate and Water

economic "value" of ag water - I?

- Average "value" for ag uses:

  < $1,000/AF capital cost

  [$40-$60/AF/year]

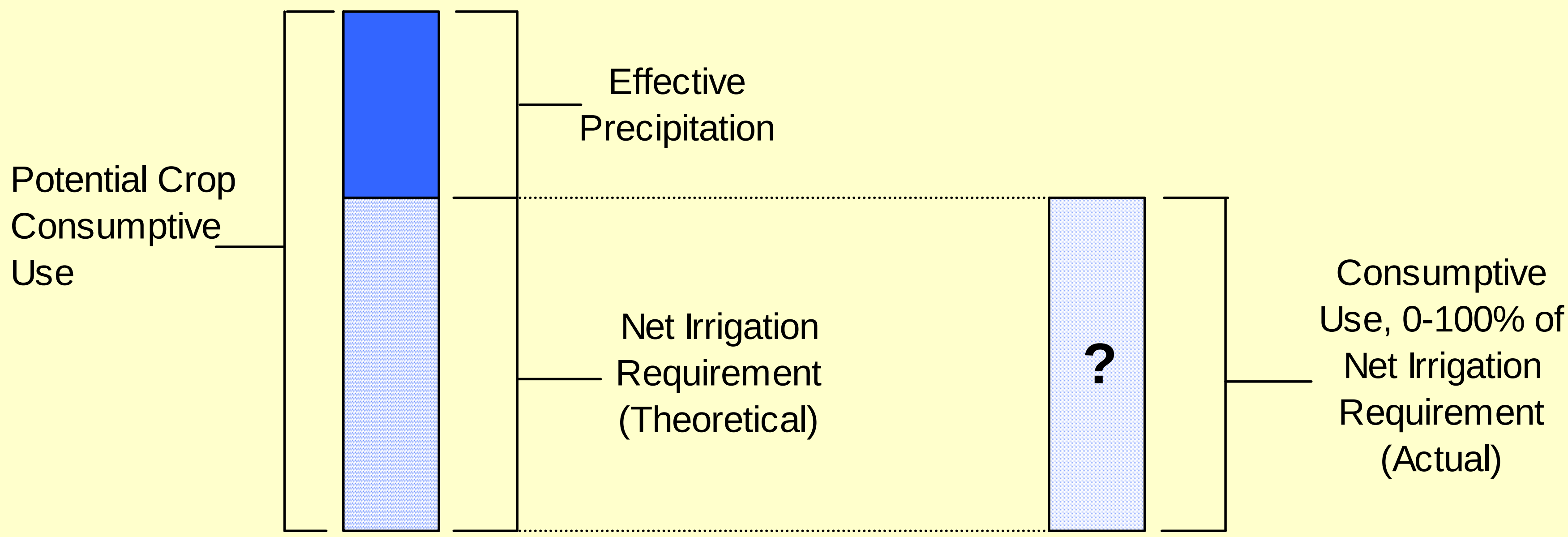
- "Values" for M&I uses:

  $2,000-$15,000/AF capital cost

Source: *Statewide Water Supply Initiative: Executive Summary* (Colorado, 2004)

1d. Agriculture, Climate, and Water: Net Irrigation Req vs. Ag Consumptive Use

Consumptive use is a % of net irrigation requirement



Colorado Dept of Agriculture, Natural Resources Conservation Service(USDA)

1e. Agriculture, Climate and Water

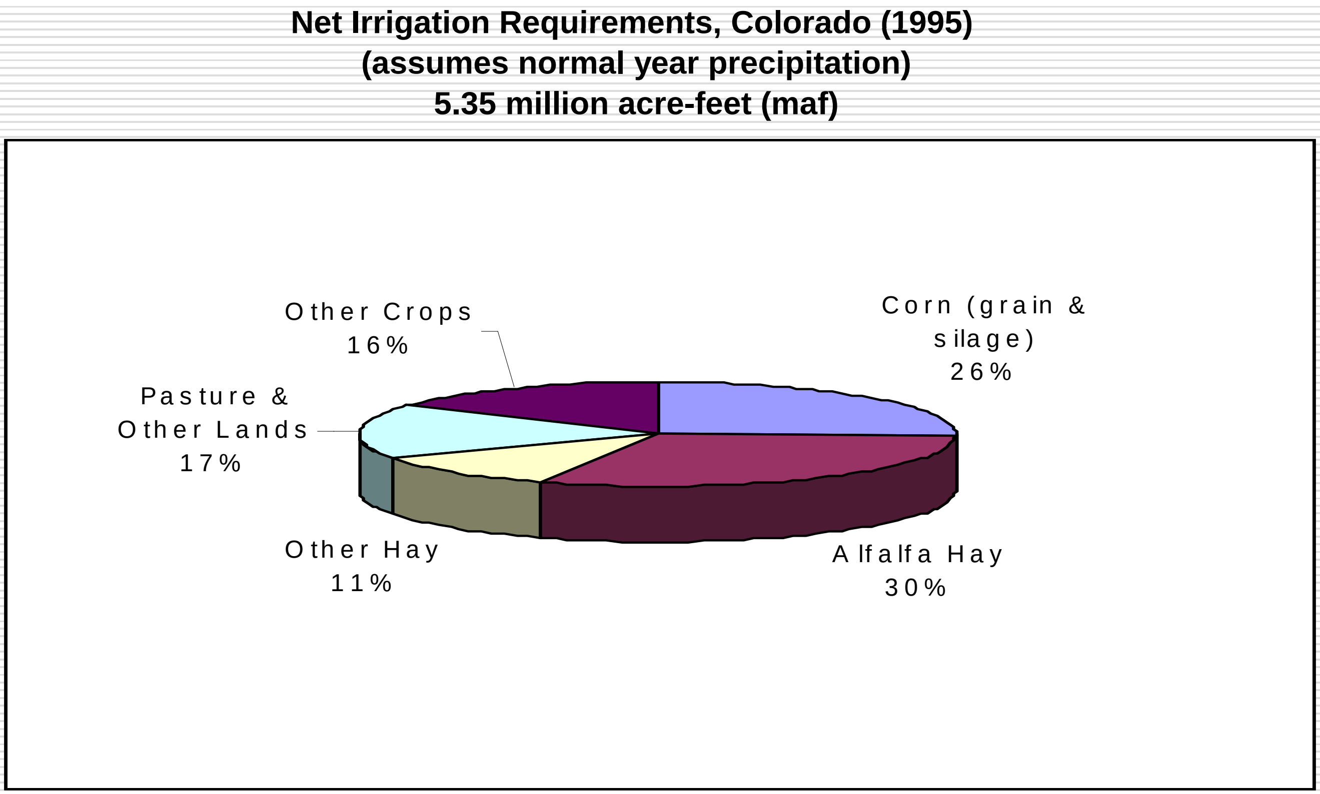
economic "value" of ag water – II?

Normal Year NIR and Crop Sales Prices, Colorado (2004)

	irrigated acres *1,000*	net irrigation requirement (NIR) *AF/acre*	crop sales price per acre-foot # *$/AF*	crop sales price per acre-foot @ *$/1000 gallons*
Dry Onions	11	0.82	$7,463	$22.90
Peaches	2	2.29	$2,674	$8.21
Sweet corn	9	1.38	$1,272	$3.90
Potatoes	70	1.53	$1,139	$3.50
Domestic water ^	???	???		$1.84
Sugar Beets	34	1.90	$505	$1.55
Corn (grain)	715	1.64	$234	$0.72
Alfalfa Hay	670	2.15	$145	$0.44
Other Hay	505	1.57	$76	$0.23

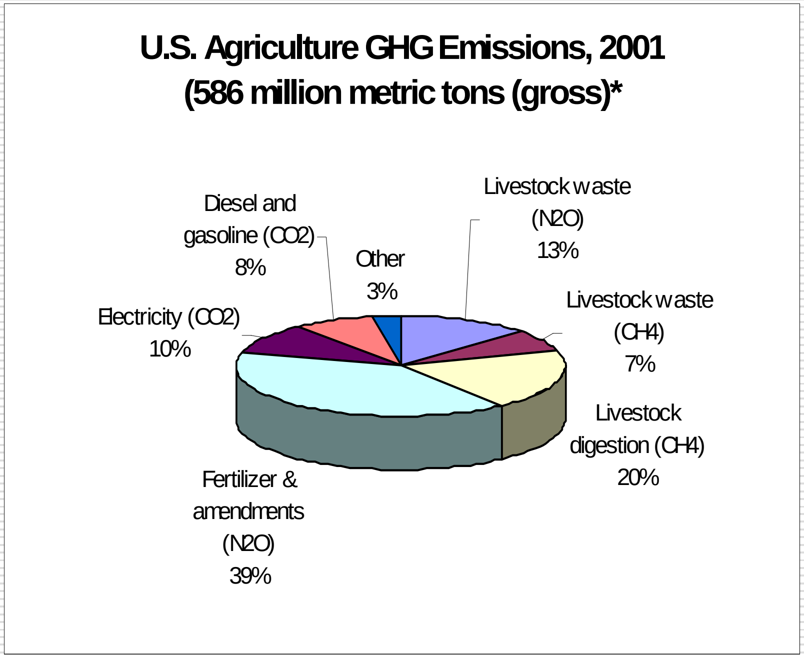
NIR = Potential Crop Consumptive Use - Effective Precipitation (Colorado *NRCS*)
"Normal year NIR" = sufficient irrigation water to produce a full yield in 5 of 10 years.
(average price received/crop unit) * irrigated yield ÷ NIR. @ 1 AF = 325,851 gallons.
^ Denver Water consumption charge for residential customers, first 22,000 gallons (2006).
Crop acreage, price and yield data: *Colorado Agricultural Statistics* (2005)

1f. Agriculture, Climate and Water: Total Colo. Normal Year NIR, 1995



Source: "Colorado's Net Irrigation Requirement for Agriculture, 1995," A. Frank and D. Carlson, 1999.

2a. U.S. Agriculture and Greenhouse Gas (GHG) Emissions:



In 2001, U.S. Agriculture accounted for 9% of total gross U.S. GHG emissions.

Total gross U.S. GHGs (6,893 MMT CO_2 eq.) were partially offset by forestry sinks of 818 MMT and ag soils sinks of 15 MMT.

Sources: *U.S. Agriculture and Forestry GHG Inventory, 1990-2001* (USDA); *US Emissions Inventory 2006* (EPA)

2b. U.S. Agriculture and GHGs

U.S. Agriculture accounts for approximately:

- "a small amount" of total U.S. CO_2 (~ 2%)
- 33% of total U.S. CH_4 (methane)
- 75% of total U.S. N_20 (nitrous oxide)

Source: "Global Climate Change: Overview" USDA, ERS (2005)

2c. U.S. Agriculture and GHGs: **Strategies to curtail GHGs**

1. Use low GHG fuels (diesel, biofuels)
2. Better management of cattle waste
3. Precision fertilizer application
4. Increase conservation tillage
5. Slow agricultural land conversion

   [A paper on a landowner-driven, landpooling approach: "Agricultural Preservation and Development Associations," D. Carlson. In *Compensating Landowners For Conserving Agricultural Land.* UC Davis, 2003.]

2d. U.S. Agriculture and Carbon Sequestration: Potential Contribution

Agro-economic models indicate that *<u>4-8 percent of gross U.S. GHGs</u>* *(2001) [72 to 160 MMT C] could be offset by agricultural practices, given an economic incentive of $125 per metric ton of sequestered carbon.*

<u>Key practices</u>:

- afforestation
- cropland → perennial grasses
- conventional → conservation tillage (esp. no-till)

Source: “Economics of Sequestering Carbon in the U.S. Agricultural Sector,” TB1909, USDA-ERS, 2004.

3a. Agriculture, Energy and Biofuels: **Energy Consumption (2004)**

U.S. total energy consumption: **100 Quads.**

- 1 Quad = 1 quadrillion Btu = 10^{15} Btu = the energy equivalent of 172 million barrels of crude oil

U.S. agriculture energy consumption: **1.7 Quads**

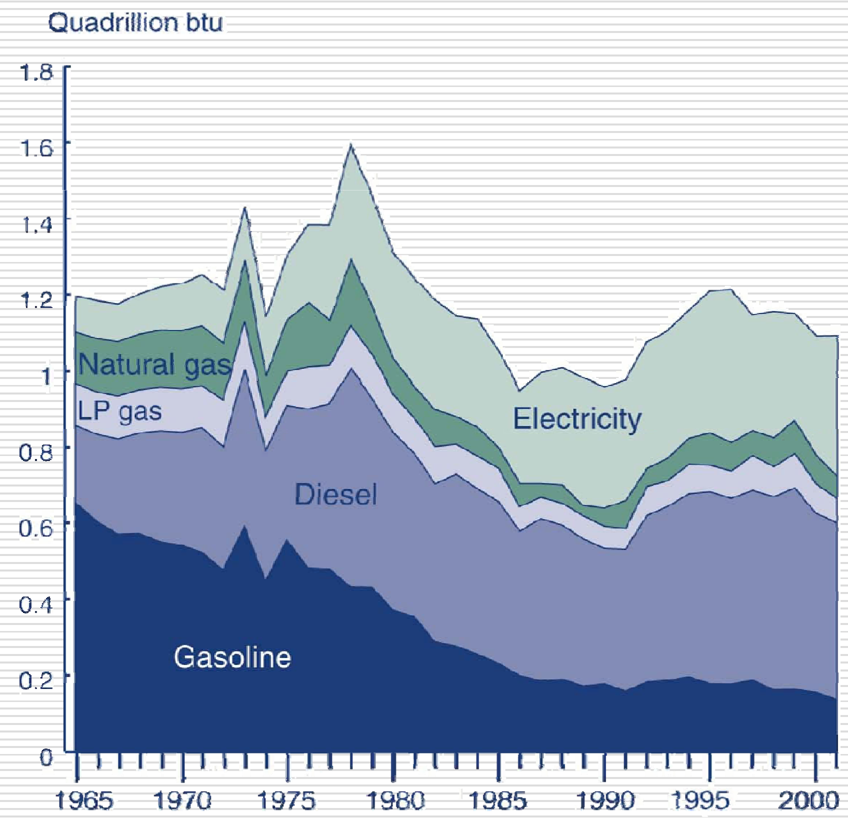
Source: Energy Information Administration, DOE

3b. U.S. Agriculture Energy Use, 1965-2001

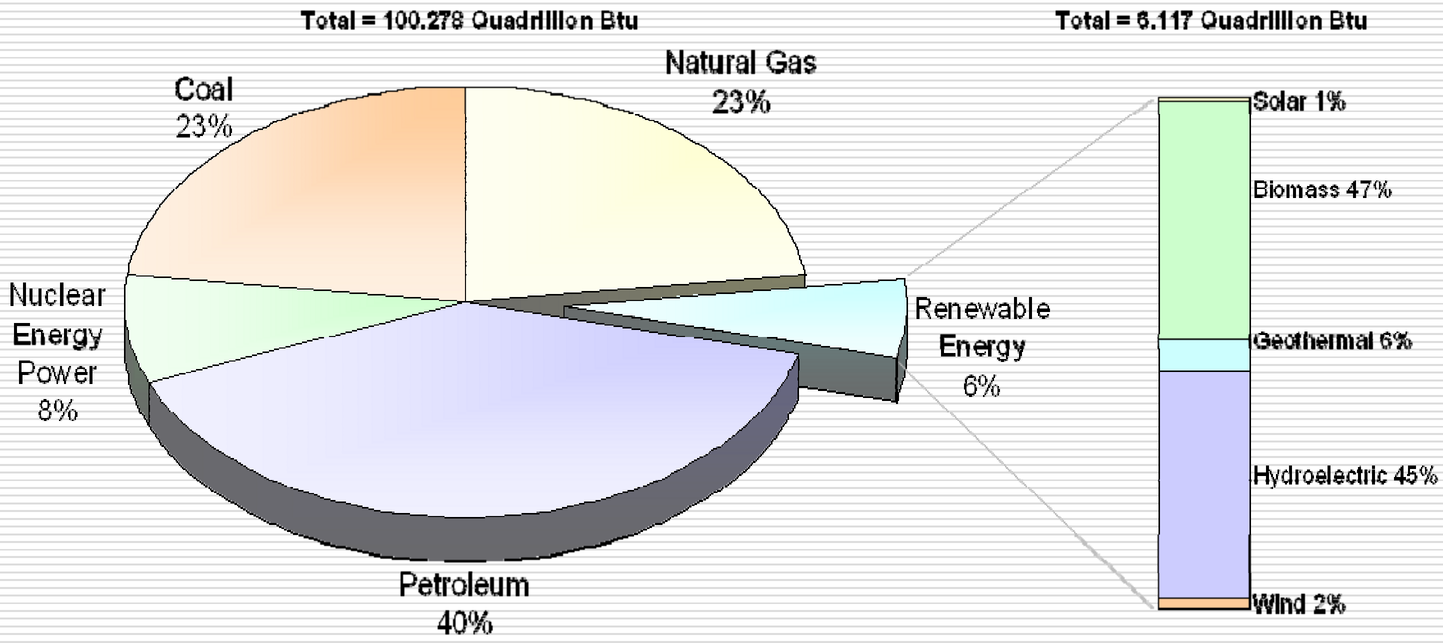
- Graph shows <u>direct</u> energy use by U.S. agriculture (1.1 Quad in 2001)

Source: *U.S. Agriculture & Forestry GHG Inventory: 1990-2001*, USDA

- <u>Indirect</u> energy (fertilizer/pesticide use) **not shown:** estimated to be 0.6 Quad in 2001



3c. U.S. Energy Consumption and Renewable Fraction (2004)



Biomass fraction includes 2 quads of wood-based energy, plus 0.3 quad of fuel ethanol (primarily corn-based).
Source: "Renewable Energy Trends 2004," Energy Information Administration, DOE.

3d. U.S. Energy & Petroleum (2004)

U.S. Petroleum consumption: 40 Quads**

- Domestic production: 14 Quads**
- Petroleum imports: 26 Quads**
- Current Biofuels production: 0.3 Quad

***Source: "Annual Energy Outlook 2006," Energy Information Administration, DOE*

"The United States desperately needs a liquid fuel replacement for oil in the future."

-- Pimentel and Patzek (2005)

3e. Biofuels: 4 key policy issues

1. What is the **petroleum** net energy balance of fuel ethanol from corn and from cellulose?
2. What are the net GHG balances?
3. What about soil erosion?
4. Can enough biofuels be produced to make a difference?

3f. Biofuels: Petroleum Net Energy Balance and net GHGs

Primary Energy Needed and GHGs Emitted to Produce 1 MJ (megajoule*) of Fuel Product

	Energy Inputs					GHG
	Petroleum	Natural Gas	Coal	Other	Total	Emissions
	------------------------MJ	-----------------------------	-----------------------------	-----------------------------	-----------------------------	kg CO_2 eq.
Product						
Gasoline	**1.10**	**0.03**	**0.05**	**0.01**	**1.19**	**94**
Ethanol (corn)	**0.05**	**0.30**	**0.40**	**0.04**	**0.79**	**81**
Ethanol (cellulose)	**0.08**	**0.02**	**-0.02**	**0.02**	**0.10**	**11**

Source: "Ethanol Can Contribute to Energy and Environmental Goals," A. Farrell *et al.*, *Science*, 27 January 2006, Vol 311, 506-508. Available via www.sciencemag.org.

*** 1 megajoule = 1 million joules ~ 948 Btu.**

This study compares six analyses of producing fuel ethanol from corn, including studies by Patzek (2004), Pimentel and Patzek (2005), Shapouri (2004), Oliveira et al. (2005), Groboski (2002), and Wang (2001). Results shown in table are based on authors' models.

3g. Ag and renewable energy: **Project 25x’25 vision**

“By 2025, America's farms, forests and ranches will provide 25 percent of the total energy consumed in the United States, while continuing to produce safe, abundant, and affordable food, feed and fiber.”

Source: www.25x’25.org

3h. Ag and renewable energy: **Project 25x'25 vision**

Realizing this vision will require more than a 10-fold increase in U.S. energy production from Biomass, Wind and Solar in 21 years

(2004 to 2025).

- Total use: 100 Quads → 127 Quads (2025)**
- B, W and S: 3 Quads → 30+ Quads (2025)
- Current production: 70 Quads (2004)**

***Source: "Annual Energy Outlook 2006," Energy Information Administration, DOE*